Title: Ellie learns about how vaccines are transported safely

Children explore how nearly all vaccines are transported and stored at low temperatures through a practical enquiry inspired by *Ellie learns about vaccination*.

Objectives

- Understand that most vaccines must be kept at low temperatures to remain safe and effective.
- Explore how vaccines are stored and transported safely.
- Recognise that some materials are better thermal insulators than others.
- Plan and carry out different types of enquiries to answer questions.
- Take measurements, using a range of scientific equipment, with increasing accuracy and precision.

Science vocabulary

- vaccine - a medicine designed by scientists to help your body learn to fight certain germs (harmful micro-organisms) that can make you ill.
- vaccination - when you get a vaccine, usually by being injected with it.
- pharmaceutical industry - a group of companies and scientists who create, test and make medicines that treat illness and help keep people healthy.
- thermal insulator – a material that helps keep things warm or cold by stopping heat from moving easily.
- cold chain - the system of keeping vaccines at the right temperature starting with the factory and on the entire journey to the person getting vaccinated.

Resources

per class

- *Ellie learns about vaccination* (ABPI) story book or website.
- Optional: vials, small bottles or plastic syringes (for demonstration only)

per group of four children working together

- x1 thermometer or temperature sensor/data logger
- x1 beaker
- 20 - 50 ml water (to represent vaccine)
- 2-3 drops food colouring (any colour)
- range of materials, including recycled fabric, bubble wrap, cardboard, kitchen foil etc.
- x1 scissors
- x3 elastic bands
- x1 timer (ideally accurate to whole seconds)
- activity sheet 4: data recording
- access to freezer
- x1 pair of gloves

Advance preparation: Beakers of an agreed amount of coloured water must be placed in a freezer prior to this activity. It is particularly helpful to remove the beakers from the freezer at least one hour prior to the activity so that children can see that the 'frozen vaccine' has begun to thaw at room temperature.

Groups of children may ask for additional equipment based on their own ideas for carrying out the enquiry. Ensure that all objects and materials can be re-used or recycled at the end of the practical activities.

Safety guidance

- Be sensitive when discussing disease or illness.
- Use toy or plastic syringes for demonstration only. Do not use real needles or liquids containing harmful ingredients.
- Supervise children closely when handling thermometers.
- Children may wear gloves when handling the frozen 'vaccine' beakers to avoid ice burn.
- Clean up any spills immediately.

Prior knowledge / experience

- Children should have a basic understanding of what vaccines are and why they are important. This is introduced in a simple way in Activity 3: *Ellie learns about vaccine development*.
- Children should know about states of matter, specifically solids and liquids, and understand that some materials change state when heated or cooled. They should have some experience of temperature measurement and recording data.
- Children should have a basic knowledge of thermal insulation as a method used to slow down or prevent heat from moving from one place to another.

Top tips

Use coloured water to make the 'vaccine' visible to children during their investigation.

The observation-over-time enquiry would be better run throughout the day with a class checking the temperature of the 'vaccine' regularly. Whilst taking and recording ongoing temperature measurements, children could complete the card sort featured in: **Ellie Learns About Vaccination Activity 1.**

Encourage children to work in teams with clear roles. You could use these role badges from CIEC. Giving each child a specific responsibility keeps everyone involved and helps practical enquiries run smoothly and safely in a busy classroom environment.

Activity notes

Introduction (15 min)
Read or watch Ellie learns about vaccination. Recap from Activity 1 that a **vaccination** is when you get a type of medicine called a **vaccine** that is usually injected into your arm or leg with a

very small, thin needle. After you have the vaccination, your body starts learning how to protect you from certain illnesses.

Revisit the learning from Activity 1 that medicines, including vaccines, are developed by people working in the **pharmaceutical industry**. Scientists work in special laboratories to mix ingredients and test them carefully to make sure they are safe to use. Once health experts approve the vaccine so that everyone can use it, engineers and machine operators work together to make lots of doses of the vaccine in their factories.

Explain that a dose of a vaccine is just one precise amount that your body needs to stay protected. Ask children to share their ideas of what they think a vaccine looks like. Collect children's initial ideas and explain that most vaccines look like a clear or slightly cloudy liquid.

Explain that the liquid vaccine is kept in a tiny bottle called a vial. Doctors or nurses are trained to use a special needle, which is hollow like a thin straw, and syringe to take the liquid from the vial and then give the vaccination, often in the arm or leg.

Transporting vaccines: (10 min)
Explain to children that vaccines usually need to be kept at low temperatures, and the exact temperature depends on the type of vaccine and the ingredients it is made from. Some are kept in a fridge (between 2 °C and 8 °C) and others must be frozen (-15°C or colder). Keeping vaccines at the right temperature helps them to work properly.

Recap from Activity 1 that vaccines are sent out from the factories where they are made, to doctors' surgeries, clinics, hospitals and pharmacies where they are given to patients. Ask children to think about how delivery drivers and pilots can transport vaccines safely at low temperatures.

Discuss children's ideas and explain that vaccines are packed in special **insulated** boxes or coolers to keep them cold. These are then loaded onto refrigerated trucks or planes and taken to storage centres where they are kept in big fridges or freezers before being delivered to where they are needed. This system of keeping vaccines at the right temperature from the factory to vaccination is called the **cold chain**. Explain that specially trained people check the temperature of the vaccines continuously using sensors or digital monitors which send alerts if the temperature changes.

Practical activity (time dependent on method used)
Explain that vaccines that are frozen for transportation must be warmed *slowly* and safely to a liquid state between 2 °C and 8 °C before they can be used.

Challenge children to change a 'frozen vaccine' from solid to liquid state and try to keep the temperature of the liquid at or below 8 °C for as long as possible.

They should work in small groups and discuss their ideas for what they could do and the equipment they would need. This part of the activity provides an excellent opportunity to uncover any misconceptions children may have about **thermal insulation**, for example: "metal will keep the vaccine cold" and "wrapping material around the beaker will warm up the vaccine."

It is important for children to follow their own lines of enquiry. One example is outlined below:

Each group is given a beaker of a small amount (20 – 50 ml) coloured water which has been placed into a freezer prior to the lesson. The water represents a vaccine that has been frozen for safe transportation. It is particularly helpful to remove the beakers from the freezer at least one hour prior to the activity so that children can see that the 'frozen vaccine' has begun to thaw at room temperature.

Measuring the start temperature of the frozen vaccine

Each group chooses one layer of a material to **insulate** their beaker. Children should be encouraged to use scissors to cut and reshape their material however they wish to, ensuring there is space to read a thermometer or temperature sensor placed into their beaker. The material can be secured with elastic bands.

Children may suggest having a 'control' to monitor at the same time as their **insulated** vaccine. They may also discuss having a control and 2-3 other vaccines wrapped with different materials within one group so they can compare between themselves as well as compare with the class. Equipment permitting, this would give members of the group one vaccine each to monitor.

Examples of how children might choose to keep their vaccine at low temperatures:

Children should record the start temperature of the 'vaccine' and start a timer.

Every five minutes, children should use a thermometer or temperature sensor to measure the temperature of the 'vaccine' in their beaker. If the water is still in the solid state (ice), this should

also be recorded. Activity sheet 4 has been provided as an example of how children may decide to record the data they collect.

Because temperature readings are taken every five minutes, children may complete optional short tasks during these intervals, such as:

- predicting the next temperature reading
- sketching their equipment set-up and labelling materials
- recording ideas for how they might improve their design.

Each group should aim to keep their 'vaccine' at or below 8 °C for as long as possible. Once the water has reached a temperature above 8 °C, children should stop the timer and record the total time passed.

To complete the activity, groups should compare how long they were able to keep their 'vaccine' at a safe temperature and discuss why some methods may have worked better than others. Displaying the full class set of results at the end of the enquiry supports meaningful evaluation and comparison and helps children draw conclusions from real data.

Questions for thinking

Use these questions to encourage discussion and check understanding:

- Why do vaccines need to be kept cold?
- How do scientists and engineers make sure vaccines stay cold over long distances?
- Which of the materials you tested kept the 'vaccine' temperature below 8 °C for the longest time? Why do you think it was most suitable?
- Did any groups test the same material? Were their results similar? Why might they differ?
- What patterns can we see in the data?
- How could you improve your method for keeping a vaccine colder for longer?

Taking it further (at home or school)

- Test a wider variety and different combinations of materials to find which keep ice cubes frozen the longest.
- With an adult, look at the packaging of different medicines. Try to find out if they should be stored at low temperatures recommended between 2 °C and 8 °C.

Industry links and ambassadors

- Find out if there are any pharmaceutical industries in your local area. Make contact to ask how they produce, store and deliver vaccines at the correct temperatures.
- Contact local transport and logistics companies to find out how they might refrigerate and freeze products to help deliver them safely across cities, countries and continents.

- Contact STEM Ambassadors to speak to the class or record a short video. Local ambassadors could talk about challenges in transporting vaccines, the equipment they use, and the teamwork involved.

ACTIVITY SHEET 4: Data recording

You can record the data you collect using the table provided below. However, you may have your own ideas.

Time (min)	Temperature of water (°C)	Observations / notes
start		
5		
10		
15		
20		
25		
30		
35		
40		
45		
50		
55		
60		